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Alternative estimates of the well-known negative relationship between the US interest rate risk and the flow-through capability

Francisco Jareño [a,*], Marta Tolentino [b], Carlos Cano [a,c]

[a] Department of Economics and Finance, University of Castilla-La Mancha, Albacete, Spain
[b] Department of Economics and Finance, University of Castilla-La Mancha, Ciudad Real, Spain
[c] Eurocaja Rural, Toledo, Spain

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ABSTRACT

This paper estimates US industries' ability to transmit inflation shocks to the prices of their products and services (flow-through capability, FTC) and the stock duration (interest rate sensitivity) at the sector level. Then, considering the significant differences in ability among industries, we analyze the relationship between FTC and interest rate sensitivity using two alternative methodologies (in both cases). Finally, we find a significant negative relationship between FTC and stock duration, as suggested by previous literature. Thus, industries with high FTC, such as S7 (Finance and Real Estate), S9 (Manufacturing), S11 (Transportation and Warehousing) and S12 (Utilities), may be less sensitive (than expected) to changes in nominal interest rates. In contrast, sectors such as S4 (Retail Trade), S8 (Information) and S10 (Professional and Administrative Services) (with high IRS) may be more sensitive (than expected) to changes in nominal interest rates, indicating a weak ability to transmit inflation shocks to the prices of their products and services.

1. Introduction

Financial risk management is an important issue (Campbell, 2006; Cano et al., 2016; and González et al., 2016, 2017); thus, an estimation of the flow-through capability (FTC) could be relevant for investors and portfolio managers. According to Estep and Hanson (1980), Asikoglu and Ercan (1992), Cano and Jareño (2015), and Jareño and Navarro (2010), among others, FTC is defined as a firm's ability to transmit inflation shocks to the prices of its products and services.

In contrast, Stone (1974), Ferrando et al. (2017) and Jareño et al. (2016), among others, analyze the nominal interest rate risk and the company's stock duration, that is, the sensitivity of stock returns to variations in nominal interest rates, which is a more relevant source of uncertainty.

Thus, the main objective of this study is to determine whether the FTC of US companies (Cano et al., 2016) is related to the nominal interest rate duration of companies' stock returns.[1]

Specifically, Asikoglu and Johson (1986, 1990) and Asikoglu and Ercan (1992) analyze the relationship between inflation and stock returns and conclude that FTC is negatively related to the company's stock duration. Furthermore, Jareño (2005) and Jareño and Navarro (2010) confirm for the Spanish stock market and Cano et al. (2016) confirm for the US stock market that there are significant differences in FTC at the sector level and that sectors with greater FTC are less sensitive to interest rate risk. Moreover, Jareño and Navarro (2010) find a robust negative relationship between the sensitivity of stock returns to changes in nominal interest rates and the FTC of Spanish companies.

This research contributes to the literature by confirming the existence of a negative relationship between the FTC of US sectors and the sensitivity of these sectors to changes in nominal interest rates (interest rate sensitivity, IRS) during the sample period 2000–2009. We start from the North American Industry Classification System (NAICS) sector classification, which Cano et al. (2016) modified. The 12 studied sectors are (1) Leisure and Accommodation, (2) Health Care and Educational Services, (3) Wholesale Trade, (4) Retail Trade, (5) Construction, (6) Forest and Mining Exploitation, (7) Finance and Real Estate, (8) Information, (9)

* Corresponding author.
E-mail address: francisco.jareno@uclm.es (F. Jareño).

[1] "(…) this flow-through capability can to some extent explain the so called "stock duration paradox", which is the difference between the theoretical stock duration derived from the DDM model and its empirical estimates. The line of reasoning suggests that if a company can pass on inflation shocks to the prices of its own outputs and then to profits and dividends, nominal interest rate changes due to variations in the expected inflation will have a limited impact on stock prices" (Jareño and Navarro, 2010).

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Manufacturing, (10) Professional and Administrative Services, (11) Transportation and Warehousing, and (12) Utilities.

Specifically, the most relevant contributions of this paper are as follows. First, we use quarterly data rather than semiannual data, as in the previous literature (Jareño, 2005; and Jareño and Navarro, 2010), to estimate FTC and IRS. Second, we compare two alternative estimates of the ability to absorb inflation (FTC). Third, we obtain the interest rate risk (IRS) by using two different terms to maturity for the nominal interest rate: 1- and 10-year maturities. Finally, we confirm a significant negative relationship between the FTC and nominal interest rate duration (IRS) for the US sectors by using two different methodologies for each estimate.

The rest of the paper is organized as follows: Section 2 includes the most important previous literature about FTC and interest rate risk, the methodology proposed and the data used in this research. Section 3 collects the FTC and IRS estimates based on Jareño and Navarro (2010) and the Stone (1974) asset pricing factor model, respectively. Section 4 studies the relationship between the two previous estimates: FTC and IRS. Finally, Section 5 emphasizes the main conclusions of this paper.

2. Materials & methods

Regarding FTC, the methodology proposed by Jareño and Navarro (2010) consists of using an indirect method to estimate the flow-through ability. By taking into account the fact that the flow-through capability is related to the ability of the firm to pass on an inflation shock to its output prices, i.e., to Δp_t, they assume that

$$\frac{\Delta p_t}{p_t} = f(\pi_t,\ \pi_{t-1},\ \ldots) = \alpha_0 + \alpha_1\pi_t + \alpha_2\pi_{t-1} + \ldots + \mu_t \quad [1]$$

where α_i measures the capability of the company to transmit current and past inflation shocks to its output prices. Thus, this parameter captures in essence the same concept that the flow-through coefficient captures. These estimates should be related to the flow-through coefficient defined by Estep and Hanson (1980) as the fraction of inflation that flows to profit (and dividend) growth.

As profit is a highly volatile variable, Jareño and Navarro (2010) use the sales variable, and they start with the following theoretical model:

$$\Delta V_t = p_{t+1}\cdot q_{t+1} - p_t \cdot q_t \quad [2]$$

where V_t is the firm revenue during period t, p_t is the mean price of the firm outputs, and q_t is the number of physical output units sold by the firm.

One of the main problems they have to address in this model is that neither p_t nor q_t are available at the firm or industry level. If the output sold is constant, then all changes in V_t would be due to changes in prices. However, production and sales volumes are seldom constant, so a control for this variable is needed. A possible proxy for q_t could be the number of employees, a datum that can be obtained from firm reports; to this end, Jareño and Navarro (2010) incorporate the total amount of employees by sector as the proxy variable for the production level as a comparison:

$$\Delta T_{ti} = \beta_0 + \beta_1\cdot\Delta NE_{ti} + \beta_2\cdot\Delta IR_t + \varepsilon_t \quad [3]$$

where NE_{ti} reflects the number of employees of the different sectors i, β_2 is the FT coefficient and ε_t refers to the error term. Moreover, for robustness, a relevant contribution in Cano et al. (2016) is to proxy q_t with the operating costs of companies.

According to Asikoglu and Ercan (1992), Jareño (2005), Jareño and Navarro (2010), and Cano et al. (2016), among others, companies characterized by higher FT capability should show higher stock prices. Furthermore, investors are willing to pay a higher stock price when most of the inflation rate positively affects the stock prices through the growth of dividends. Therefore, increases in the FTC are associated with higher stock prices. As a result, in sectors with higher FT coefficients, stock prices would be less sensitive to inflation shocks. The reason may be that if a company can pass on inflation shocks to the prices of its own outputs and then to profits and dividends, nominal interest rate changes due to variations in the expected inflation will have a limited impact on stock prices (Jareño and Navarro, 2010).

With respect to IRS, previous literature applies different estimation methods of stock price sensitivity to variations in nominal interest rates. Thus, the bulk of literature has focused on the Stone (1974) two-factor model (Jareño, 2006, and Jareño et al., 2019, among many others):

$$r_{jt} = \alpha_j + \beta_j\cdot r_{mt} + \gamma_j\cdot\Delta i^u_t + \varepsilon_{jt} \quad [4]$$

where r_{jt} is the sector j return in time t, β_j shows the sensitivity of the sector j to changes in the market return, r_{mt} refers to the stock market return in period t, γ_j indicates the sector j return sensitivity to unexpected changes in nominal interest rates, Δi^u_t represents unexpected changes in nominal interest rates and ε_{jt} is a random disturbance.

This two-factor model complements the explanatory power of the CAPM model. Furthermore, some authors (Tessaromatis, 2003; Jareño, 2006; Jareño et al., 2016, 2019; Sevillano and Jareño, 2017) introduce an extension of the Stone (1974) two-factor model. In particular, this model formulates the sector stock returns based on the real interest rate, stock market portfolio return and expected inflation rate.

Although previous literature has proposed other factor models, such as the Fama and French (1993) three- and five-factor model (Jareño, 2008; Campos et al., 2016; Jareño et al., 2018), and other procedures (Jammazi et al., 2017), such as the quantile regression (QR) approach (Ballester et al., 2011; Jareño et al., 2016; Ferrando et al., 2017; Sevillano and Jareño, 2018; Umar et al., 2018; González and Jareño, 2019), this research is based on the seminal research of Stone (1974) (Tessaromatis, 2003, Soto et al., 2005, and Jareño, 2006, among others).

Finally, regarding data, this paper starts from the FTC estimates of Cano et al. (2016), who use data from 40 quarters from 2000 to 2009, the sectoral S&P 500 classification and the following variables: the turnover for each sector (from companies listed in the S&P 500), the US inflation rate, and operating costs (alternative 1) and the number of employees (alternative 2) of companies as alternative proxy variables of the company production (Everaert and De Simone, 2007; Jareño and Navarro, 2010; among others).[2] Additionally, to estimate IRS at the sector level, the following variables are considered: the quarterly sector stock returns, the quarterly US stock market return (proxied by the S&P 500 index),[3] and the quarterly 1-year (Ferrando et al., 2017) and 10-year (Tessaromatis, 2003; Jareño, 2006, 2008; Campos et al., 2016; Jareño et al., 2016) interest rates.

The main descriptive statistics of the previous variables and the stationarity and unit root tests are collected in Table 1. These tests confirm the stationarity of the time series turnover, operating costs and the number of employees at the sector level (in first differences), (long- and short-term) interest and inflation rates (in first differences), and stock market and sector portfolio returns.

In particular, the average values for turnover and operating costs are positive, whereas they are negative for the number of employees, stock market and sector portfolio returns, and interest and inflation rates. With regard to standard deviations, operating costs, the number of employees and changes in inflation rates are less volatile than the rest of variables. There is no clear pattern of skewness because it is negative for changes in operating costs, the number of employees and inflation rates and mainly positive for sector portfolio and stock market returns and changes in interest rates. The kurtosis coefficient is mostly close to or greater than 3;

[2] Data extracted from the Thomson Reuters database, except for the interest rate (published by Eurostat). Please see Cano et al. (2016) for further information.

[3] Obtained from https://www.quandl.com/search?query=turnover%20s%26p%20500&type=all, the website of Quandl.

Table 1
Descriptive statistics of dependent and independent variables.

Panel A: Sector portfolio: turnover in first differences (ΔT)

Sector	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	ADF stat.	PP stat.	KPSS stat.
Leisure and Accommodation	0.2498	0.1932	1.4214	-0.5047	0.4022	0.6128	3.6242	-6.1230***	-6.1659***	0.0441
Health Care and Educational Services	0.3045	0.2681	0.9966	-0.4043	0.2530	0.6118	5.5727	-8.8978***	-17.8234***	0.1038
Wholesale Trade	0.0829	0.0798	0.3295	-0.2676	0.1123	-0.3890	4.5439	-6.2615***	-6.9319***	0.1186
Retail Trade	0.0765	0.0913	0.1837	-0.1267	0.0637	-1.6039	5.9688	-9.1831***	-9.4036***	0.2347
Construction	0.0397	0.0507	0.3124	-0.2947	0.1451	-0.3201	2.2738	-6.7465***	-6.8007***	0.0813
Forest and Mining Exploitation	0.4258	0.3872	3.0081	-0.6873	0.6119	1.6663	9.1281	-5.5648***	-13.5953***	0.0735
Finance and Real Estate	0.2107	0.3019	0.8191	-0.5021	0.3385	-0.3542	2.2116	-4.1824***	-4.2074***	0.1300
Information	0.0936	0.0917	0.2159	-0.1884	0.0852	-0.9051	4.3894	-6.8860***	-6.8860***	0.0859
Manufacturing	0.0576	0.0999	0.1963	-0.3015	0.1183	-1.5784	5.0723	-6.2788***	-3.4696***	0.0432
Professional and Administrative Services	0.0447	0.0902	0.4260	-0.2145	0.1426	0.0802	3.0042	-6.2986***	-6.7132***	0.2249
Transportation and Warehousing	0.0384	0.0897	0.4383	-0.3266	0.1621	-0.5387	3.3466	-6.6850***	-6.6849***	0.0542
Utilities	0.0635	0.0468	0.8139	-0.4986	0.2568	0.6878	5.1890	-4.5516***	-9.8051***	0.0555

Panel B: Sector portfolio: operating costs in first differences (ΔOC)

Sector	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	ADF stat.	PP stat.	KPSS stat.
Leisure and Accommodation	0.0421	0.0473	0.0957	-0.0370	0.0316	-0.4314	2.7469	-4.4436***	-4.5448***	0.0976
Health Care and Educational Services	0.0640	0.0649	0.0942	0.0302	0.0169	-0.3227	2.5735	-3.9043***	-3.9553***	0.1720
Wholesale Trade	1.4114	0.0340	5.7865	-0.0618	9.0362	6.1664	3.9025	-3.0099***	-7.4768***	0.1635
Retail Trade	0.0182	0.0220	0.0699	-0.0578	0.0293	-0.9720	4.0008	-2.8217**	-2.9369**	0.2347
Construction	0.0186	0.0336	0.1247	-0.1903	0.0744	-1.3436	4.5564	-2.8530**	-5.2727***	0.3573
Forest and Mining Exploitation	0.0523	0.0621	0.1741	-0.2031	0.0940	-0.8729	3.2708	-3.8427***	-3.8318***	0.3328
Finance and Real Estate	0.0431	0.0430	0.0879	-0.0216	0.0260	-0.4262	3.0356	-3.1630***	-6.1304***	0.0931
Information	0.0304	0.0361	0.1093	-0.0579	0.0458	-0.2748	2.5323	-2.6323**	-3.4785***	0.1062
Manufacturing	-0.0155	-0.0017	0.0493	-0.1607	0.0516	-1.1436	3.7256	-3.0436***	-3.6104***	0.1586
Professional and Administrative Services	0.0474	0.0545	0.1212	-0.0403	0.0473	-0.2415	1.8527	-2.6830**	-2.8807**	0.1684
Transportation and Warehousing	0.0231	0.0322	0.0771	-0.0700	0.0372	-0.8784	3.0036	-2.5656*	-2.8651**	0.1171
Utilities	0.0214	0.0203	0.0830	-0.0283	0.0277	0.2773	2.1966	-5.3384***	-5.2995***	0.1294

Panel C: Sector portfolio: number of employees in first differences (ΔNE)

Sector	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	ADF stat.	PP stat.	KPSS stat.
Leisure and Accommodation	0.0256	0.0374	0.0789	-0.0693	0.0399	-1.0541	3.0207	-4.7016***	-4.7350***	0.1413
Health Care and Educational Services	0.0550	0.0504	0.0919	0.0224	0.0175	0.7005	2.9750	-5.6534***	-5.7276***	0.0939
Wholesale Trade	-0.0047	-0.0010	0.0254	-0.0663	0.0258	-0.8208	2.8074	-2.3066*	-2.6940**	0.2283
Retail Trade	-0.0021	0.0033	0.0266	-0.0542	0.0209	-1.0921	3.5681	-2.4621*	-2.6484*	0.1267
Construction	-0.0049	0.0093	0.0712	-0.1761	0.0630	-1.4214	4.3863	-2.5561*	-2.6108**	0.3239
Forest and Mining Exploitation	-0.0227	-0.0171	0.1286	-0.2618	0.0793	-1.1686	5.0455	-4.4556***	-4.4987***	0.3557
Finance and Real Estate	0.0031	0.0165	0.0516	-0.1135	0.0412	-1.6188	4.8510	-3.8065***	-2.9561***	0.2938
Information	-0.0167	-0.0190	0.0743	-0.0679	0.0403	0.7088	2.9389	-2.6882**	-2.5861*	0.1847
Manufacturing	-0.0360	-0.0213	-0.0005	-0.1297	0.0363	-1.0992	3.2757	-4.5588***	-2.4878*	0.1800
Professional and Administrative Services	0.0099	0.0306	0.0877	-0.1627	0.0720	-0.9014	2.7717	-2.5947*	-2.7502**	0.1431
Transportation and Warehousing	-0.0010	0.0088	0.0292	-0.0691	0.0290	-0.9521	2.7206	-2.4989*	-2.9539***	0.1690
Utilities	-0.0082	-0.0083	0.0152	-0.0376	0.0137	-0.1778	2.4355	-3.4238***	-3.5149***	0.1094

Panel D: Sector portfolio: sector stock returns (r_s)

Sector	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	ADF stat.	PP stat.	KPSS stat.
Leisure and Accommodation	-0.0237	-0.0944	2.9537	-3.0900	1.2347	0.4021	0.4021	-5.7086***	-8.1658***	0.0461
Health Care and Educational Services	0.1067	-0.0107	8.1860	-2.6063	1.4847	4.0858	9.5673	-5.6574***	-3.1233**	0.1068
Wholesale Trade	-0.1393	-0.1743	3.0010	-3.5924	0.9348	-0.4511	6.7665	-2.3066*	-3.9318***	0.1146
Retail Trade	0.0136	0.0087	1.2212	-0.7454	0.4189	0.5741	3.7629	-4.4671***	-8.4036***	0.0867
Construction	0.0093	0.1001	1.8737	-2.9814	0.9718	0.3958	4.2216	-2.552	-2.8027*	0.2113
Forest and Mining Exploitation	-0.1955	-0.0028	1.2821	-3.6224	0.9224	-1.8068	7.4969	-4.4576***	-9.5353***	0.0041
Finance and Real Estate	-0.1955	-0.0028	1.2821	-3.6231	0.9224	-1.8068	7.4969	-3.8075***	-4.2077***	0.1290
Information	0.1042	0.0040	3.3085	-3.0676	0.9930	0.7118	6.8006	-2.6882**	-2.8857*	0.0889
Manufacturing	-0.1205	0.0318	2.4984	-2.5585	0.9459	-0.3182	4.6529	-4.5488***	-3.4646**	0.0452
Professional and Administrative Services	-0.1992	-0.0873	1.9502	-2.9067	0.9863	-0.6589	4.0974	-5.5447***	-6.7172***	0.2269
Transportation and Warehousing	0.0393	-0.0330	1.7085	-0.9066	0.5736	0.6739	3.6933	-2.4989*	-6.6849***	0.0562
Utilities	-0.1191	-0.1619	0.9275	-0.9679	0.4909	0.1248	2.2794	-2.4268**	-7.8058***	0.0558

Panel E: Inflation and interest rates

Explanatory variable	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	ADF stat.	PP stat.	KPSS stat.
Changes in inflation rates	-0.0002	-0.0001	0.04265	-0.0489	0.0136	-0.3896	7.5612	-7.3453***	-4.5112***	0.0377
Stock market returns	-0.0009	-0.0255	0.3478	-0.2184	0.1070	0.9272	4.6268	-3.1858**	-3.3518**	0.1100
Changes in 10-year interest rates	0.0106	-0.0128	1.0343	-0.7917	0.3999	0.5863	3.1935	-4.3993***	-6.8237***	0.1245
Changes in 1-year interest rates	-0.0230	-0.1967	1.9337	-2.0740	0.7310	0.4067	4.6010	-2.5575*	-5.9717***	0.1016

Notes: This table presents the descriptive statistics of monthly sector portfolio returns as well as of the three interest rate factors and the remaining risk factors considered over the period from 2000 to 2009. They include mean, median, minimum (Min.) and maximum (Max.) values; standard deviation (Std. Dev.); and skewness and kurtosis measures. The results of the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests and the Kwiatkowski et al. (KPSS) stationarity test are also reported in the last three columns. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

thus, most series have heavy tails.

3. Results

3.1. FTC estimate

This research departs from the FTC estimates of the US companies in Cano et al. (2016). In turn, these estimates are based on the methodology proposed by Jareño (2005) and Jareño and Navarro (2010), as applied to the United States, to estimate the relevant FT capability of each company depending on the sector to which it belongs. Furthermore, for robustness, this paper uses two alternative proxy variables of the company production (Everaert and De Simone, 2007; Jareño and Navarro, 2010; among others): operating costs (alternative 1) and the number of employees (alternative 2) of companies.

3.1.1. The US FTC estimate: alternative 1

To obtain the sectoral FTC, Cano et al. (2016) estimate a system of 12 sectoral equations (one for each sector) using the following seemingly unrelated regression (SUR):[4]

$$\Delta T_{ti} = \beta_0 + \beta_1 \cdot OC_{ti} + \beta_2 \cdot \Delta IR_t + \varepsilon_t \quad [5]$$

where T_{ti} refers to the turnover for each sector i, OC_{ti} reflects the operating costs of the different sectors i, IR_t is the US inflation rate for 2000–2009, β_0 is the independent term, β_1 measures the variation in turnover for each activity sector as a result of unit variations in operating costs, and β_2 estimates the sectoral FTC and ε_t refers to the error term.

Table 2 shows the estimated coefficients β_0, β_1 and β_2, which represent the FT coefficients. As seen in the table, the results are significantly different from zero and the sign of the FT coefficient is positive in four sectors (S7, S9, S11 and S12): Finance and Real Estate, Manufacturing, Transportation and Warehousing and Utilities. For the rest of the sectors, the results are not significantly different from zero.

3.1.2. The US FTC estimate: alternative 2

Cano et al. (2016) alternatively estimate the FT coefficients following the method proposed by Jareño and Navarro (2010) and applied by Jareño and Tolentino (2012), Díaz and Jareño (2009, 2013), Jareño and Navarro (2016), Peiró (2016) and Cano et al. (2016), among others.

As noted above, this approximation incorporates the total number of employees by sector as the proxy variable for the production level as a comparison [Eq. 3]. Table 3 displays the alternative FTC estimates, and these results confirm that S7, S9, S11 and S12 present a significantly positive FT capability that coincides with the previous estimation. Nevertheless, in this case, S4—Retail Trade—shows results that are significantly different from zero, but the FTC is negative.

Thus, Cano et al. (2016) find consistent FTC estimate results, regardless of the proxy variable used for the production level. Furthermore, they find relevant differences between sectoral FTC estimates; thus, companies have different capabilities to transfer inflation shocks to prices of their products or services. According to Cano et al. (2016), there is a positive relationship between the variables (inflation and prices) for the following sectors: Finance and Real Estate, Manufacturing, Transportation and Warehousing and Utilities. However, there is a negative relationship between the variables of inflation and prices for the sector Retail Trade.

3.1.3. Discussion about the FTC results

The FTC, as estimated using two different methodologies by Cano et al. (2016), diverges substantially among sectors, in line with Asikoglu and Ercan (1992) and Jareño and Navarro (2010). Thus, these results anticipate a direct relationship between changes in sector stock prices and FTC. Furthermore, industries with high FTC are normally less sensitive to changes in nominal interest rates according to Jareño (2005) and Jareño and Navarro (2010), among others. Moreover, Cano et al. (2016) confirm that "this is not due to the presence of a negative relationship between inflation and stock price levels, although it is true that in those sectors in which FT capability is relatively high, inflation shocks are transmitted, practically in their entirety, to the price of products sold and services provided. Therefore, investors trust stock prices given that their valuation can remain intact."

Table 2
The US FTC estimation: alternative 1. This table shows the US FTC estimation at the sector level in Cano et al. (2016). The sample extended from 2000-2009, and the regression was estimated using SUR methodology: $\Delta T_{ti} = \beta_0 + \beta_1 \cdot \Delta OC_{ti} + \beta_2 \cdot \Delta IR_t + \varepsilon_t$ where T_{ti} refers to the turnover for each sector i, OC_{ti} reflects the operating costs of the different sectors i, IR_t refers to the US inflation rate and ε_t refers to the error term.

SECTORS	FTC
Leisure and Accommodation	2.7595 (0.7215)
Health Care and Educational Services	-0.0025 (-0.0007)
Wholesale Trade	1.3870 (1.3515)
Retail Trade	-0.6372 (-1.2141)
Construction	0.6797 (0.5515)
Forest and Mining Exploitation	7.9961 (0.9299)
Finance and Real Estate	4.2943*** (2.5848)
Information	-0.6974 (-1.0272)
Manufacturing	3.5957*** (7.0050)
Professional and Administrative Services	0.2653 (0.2009)
Transportation and Warehousing	2.8149*** (1.9846)
Utilities	4.3839* (1.4127)

*p < 0.15; **p < 0.10; ***p < 0.05 (*t*-statistics in parentheses).

3.2. IRS estimate

As described above, this paper estimates the sensitivity of US sector stock returns to changes in nominal interest rates using two alternative variables with different terms to maturity: the 1- and 10-year interest rates. To estimate Eq. (4), we include quarterly sector portfolio and stock market returns, and changes in 10- and 1-year interest rates (long- and short-term interest rates, respectively), in order to check the robustness of our IRS estimates.

3.2.1. The US stock duration estimate: alternative 1 (10-year interest rate)

In the first proposal, we include the 10-year nominal interest rate (Stone, 1974; Tessaromatis, 2003; Jareño, 2008). Thus, estimates for a

Table 3
The US FTC estimation: alternative 2. This table shows the US FTC estimation at the sector level in Cano et al. (2016). The sample extended from 2000-2009, and the regression was estimated using SUR methodology: $\Delta T_{ti} = \beta_0 + \beta_1 \cdot \Delta NE_{ti} + \beta_2 \cdot \Delta IR_t + \varepsilon_t$ where T_{ti} refers to the turnover for each sector i, NE_{ti} reflects the number of employees of the different sectors i, IR_t refers to the US inflation rate and ε_t refers to the error term.

SECTORS	FTC
Leisure and Accommodation	4.1586 (1.0392)
Health Care and Educational Services	0.6956 (0.1970)
Wholesale Trade	0.9028 (0.8147)
Retail Trade	-1.0549*** (-1.9620)
Construction	-0.3211 (-0.2555)
Forest and Mining Exploitation	11.2182 (1.3139)
Finance and Real Estate	3.6408*** (2.0031)
Information	-0.5894 (-0.8547)
Manufacturing	4.4087*** (7.6214)
Professional and Administrative Services	0.6875 (0.4762)
Transportation and Warehousing	2.5387*** (1.7946)
Utilities	4.5480* (1.4383)

*p < 0.15; **p < 0.10; ***p < 0.05 (*t*-statistics in parentheses).

[4] This method avoided problems related to heteroscedasticity and a possible contemporary correlation between the different equations' error terms.

system of 12 sector equations using the SUR technique are collected in Table 4.

These results confirm that sectors such as Leisure and Accommodation, Retail Trade, Forest and Mining Exploitation, Information, and Professional and Administrative Services show an IRS that is significantly different from zero. Moreover, the sign of significant coefficients is negative, which is in line with the bulk of reviewed literature and shows an inverse relationship between changes in nominal interest rates over 10 years and sector stock returns.

3.2.2. The US stock duration estimate: alternative 2 (1-year interest rate)

In this subsection, we estimate the sensitivity coefficients using the second alternative, which consists of replacing the nominal 10-year US interest rate with its analogous 1-year interest rate. Therefore, this estimate focuses on the short term to capture the immediate effect of economic phenomena. Thus, it is possible to compare the results obtained in both cases and analyze whether they are in line with previous studies. Equation [4] is estimated using the SUR technique again, and these results are displayed in Table 5.

The significant IRS coefficients according to the first alternative maintain this statistical significance in this second estimate with the exception of the Information Technology sector. In addition, we find another significant IRS for the sector Finance and Real Estate Services, although it has a positive sign. Additionally, as seen using the 10-year interest rate, we can generalize an inverse relationship between sector stock returns and the evolution of the 1-year nominal interest rate, which is in line with the previous literature. Similarly, the estimated coefficients in this second alternative take slightly lower values than in the previous alternative, which shows a lower impact on sectoral stock returns.

3.2.3. Discussion of the IRS results

The sensitivity of sectoral returns to changes in the nominal interest rate is significantly different among the industries analyzed in the sample period 2000–2009, which is in line with Lynge and Zumwalt (1980), Foerster and Sapp (2003), Ferrando et al. (2017), among many others. Thus, companies show differences in the ability to transfer movements in nominal interest rates into the stock prices as a result of various factors: market power, company size, growth opportunities, level of indebtedness and inflation rate. Hence, a clear relationship is found with the FTC studied in the first part of this research.[5] Therefore, another factor that has a determining influence on sectoral IRS is the liquidity level of the company, which acts as a dampener of inflation and establishes a negative relationship with this type of IRS.

For both alternatives, we find a significantly negative IRS, as suggested by Tessaromatis (2003), Jareño (2006), Jareño (2008) and Jareño et al. (2016). Thus, a decline in the nominal interest rates leads to an improvement in the stock price and vice versa. In particular, a fall in the nominal interest rates promotes the implementation of new projects by companies because the cost of financing these projects will be lower than it was before. With its implementation, an attraction is generated in the stock market that leads to improvements in stock prices, which indicates an inverse relationship between the interest rate and the stock price.

Furthermore, the impact of the long-term interest rate (10-year) on sector stock returns would be higher than that derived from the short term (1-year). In particular, the resulting coefficients are negative and statistically significant in sectors Retail Trade, probably due to the small size of the companies and the higher level of debt; Professional and Administrative Services; Information; and Leisure and Accommodation, characterized by strong competition. The negative and statistically significant IRS for the sector Forest and Mining Exploitation is higher due to the large size of companies and potential growth opportunities, which are heavily influenced by the economic situation. This result is consistent with those of Ferrando et al. (2017), among others.

Table 4
The US IRS estimation: alternative 1 (10-year interest rates). This table shows the US IRS estimation at the sector level. The sample extended from 2000-2009, and the regression was estimated using SUR methodology: $r_{jt} = \alpha_j + \beta_j \cdot r_{mt} + \gamma_j \cdot \Delta i^u_t + \varepsilon_{jt}$ where r_{jt} is the sector j return in time t, β_j shows the sensitivity of the sector j to changes in the market return, r_{mt} refers to the stock market return in period t, γ_j indicates the sector j return sensitivity to unexpected changes in the 10-year nominal interest rates, Δi^u_t represents unexpected changes in nominal interest rates and ε_{jt} is a random disturbance.

SECTORS	IRS
Leisure and Accommodation	-0.1541** (1.8921)
Health Care and Educational Services	0.1083 (-0.7102)
Wholesale Trade	-0.0601 (0.6206)
Retail Trade	-0.0320*** (-2.9370)
Construction	0.0242 (0.2781)
Forest and Mining Exploitation	-0.4219* (-1.9834)
Finance and Real Estate	0.0307 (0.0589)
Information	-0.0151** (-2.2732)
Manufacturing	-0.0125 (0.2476)
Professional and Administrative Services	-0.0715** (-1.8438)
Transportation and Warehousing	-0.0355 (-1.4610)
Utilities	-0.2126 (-1.6140)

*p < 0.15; **p < 0.10; ***p < 0.05 (*t*-statistics in parentheses).

Table 5
The US IRS estimation: alternative 2 (1-year interest rates). This table shows the US IRS estimation at the sector level. The sample extended from 2000-2009, and the regression was estimated using SUR methodology: $r_{jt} = \alpha_j + \beta_j \cdot r_{mt} + \gamma_j \cdot \Delta i^u_t + \varepsilon_{jt}$ where r_{jt} is the sector j return in time t, β_j shows the sensitivity of the sector j to changes in the market return, r_{mt} refers to the stock market return in period t, γ_j indicates the sector j return sensitivity to unexpected changes in the 10-year nominal interest rates, Δi^u_t represents unexpected changes in nominal interest rates and ε_{jt} is a random disturbance.

SECTORS	IRS
Leisure and Accommodation	-0.0532* (-1.9402)
Health Care and Educational Services	-0.0433 (-1.1215)
Wholesale Trade	-0.1132 (-0.0766)
Retail Trade	-0.0121** (-2.1014)
Construction	-0.0919 (-0.8191)
Forest and Mining Exploitation	-0.2691*** (-2.5881)
Finance and Real Estate	0.0943* (1.8183)
Information	-0.0958** (2.0385)
Manufacturing	0.0125 (1.3951)
Professional and Administrative Services	-0.0147*** (2.6928)
Transportation and Warehousing	0.0046 (-0.5289)
Utilities	-0.1076 (-0.8182)

*p < 0.15; **p < 0.10; ***p < 0.05 (*t*-statistics in parentheses).

4. Discussion

This section studies the relationship between FTC and IRS, as estimated above. According to Estep and Hanson (1980), Asikoglu and Ercan (1992), Jareño (2005) and Jareño (2006), those sectors or companies with greater FTC (the ability to transfer inflation changes to the prices of their products) exhibit less IRS. Additionally, this improved capability may maintain a negative relationship with the nominal interest rate; that is, it is expected to obtain an inverse relationship between FTC and IRS.

Moreover, four alternative estimates are made to determine the sign and intensity of the studied relationship due to the existence of a double alternative for both FTC (using the number of employees and operating costs as a proxy for the level of production) and IRS (using the 10- and 1-year nominal interest rates). Thus, the equation that relates both coefficients is estimated by ordinary least squares (OLS) adjusted by the

[5] According to Jareño and Navarro (2010) and Jareño and Tolentino (2012), among others, the nominal interest rate consists of two components: the real interest and the inflation rate.

Table 6
Estimation of the relationship between interest rate sensitivity (IRS) and flow-through capability (FTC). This table gathers the results of the model proposed by Jareño and Navarro (2010) to study the relationship between the FTC of companies classified at the sector level and their IRS. The sample extends from 2000-2009, and the regression was estimated by ordinary least squares (OLS) adjusted by the White standard error (to avoid heteroscedasticity issues): $IRS_j = \gamma_0 + \gamma_1 \cdot FTC_j + \varepsilon_j$ where IRS_j refers to the estimated IRS for each sector j, FTC_j reflects the FTC of the analyzed sectors, γ_1 is the coefficient that measures the connection between IRS and FTC and γ_0 is the independent term. Then, the four estimates are shown, as are scatter plots associated with each alternative dispersion for comparison.

Panel A	γ_1	R^2	Adj. R^2
Operating costs & 10-y interest rates	-0.13791*** (-2.6238)	0.5146	0.4229
Panel B	γ_1	R^2	Adj. R^2
N. of employees & 10-y interest rates	-0.0863* (-1.8724)	0.0164	0.0003
Panel C	γ_1	R^2	Adj. R^2
Operating costs & 1-y interest rates	-0.1097*** (-2.5801)	0.1566	0.0996
Panel D	γ_1	R^2	Adj. R^2
N. of employees & 1-y interest rates	0.0981 (0.1075)	0.0533	0.0004

*p < 0.15;**p < 0.10;***p < 0.05 (*t*-statistics in parentheses).

White standard error to avoid heteroskedasticity:

$$IRS_j = \gamma_0 + \gamma_1 \cdot FTC_j + \varepsilon_j \quad [6]$$

where IRS_j refers to the estimated IRS for each sector j, FTC_j reflects the FTC of the analyzed sectors, γ_1 is the coefficient that measures the connection between the IRS and the FTC and γ_0 is the independent term. The four estimates and scatter plots associated with each alternative dispersion are shown for comparison.

First, Table 6 shows the relationship between the IRS obtained using the 10-year interest rates and the FTC estimated from the operating costs (Panel A) and the average number of employees (Panel B). This relationship (γ_1) is negative and statistically significant in Panel A (but not in Panel B), which is in accordance with the previous literature (i.e., Jareño and Navarro, 2010, concerning the Spanish stock market). Fig. 1 displays the scatter plot to compare the IRS estimates (on the x-axis) to the FTC estimates (on the y-axis). The trendline of this plot shows a negative relationship between the IRS and FTC estimates at the sectoral level. Furthermore, in Panel A, the explanatory power of this relationship (R^2) is very high: more than 50%. Nevertheless, in Panel B, γ_1 has a relatively low value, so the slope of the trendline is less steep than in the prior case.

For robustness, Panel C and Panel D of Table 6 show the relationship between the IRS obtained using the 1-year interest rates and the FTC estimated from the operating costs and the average number of

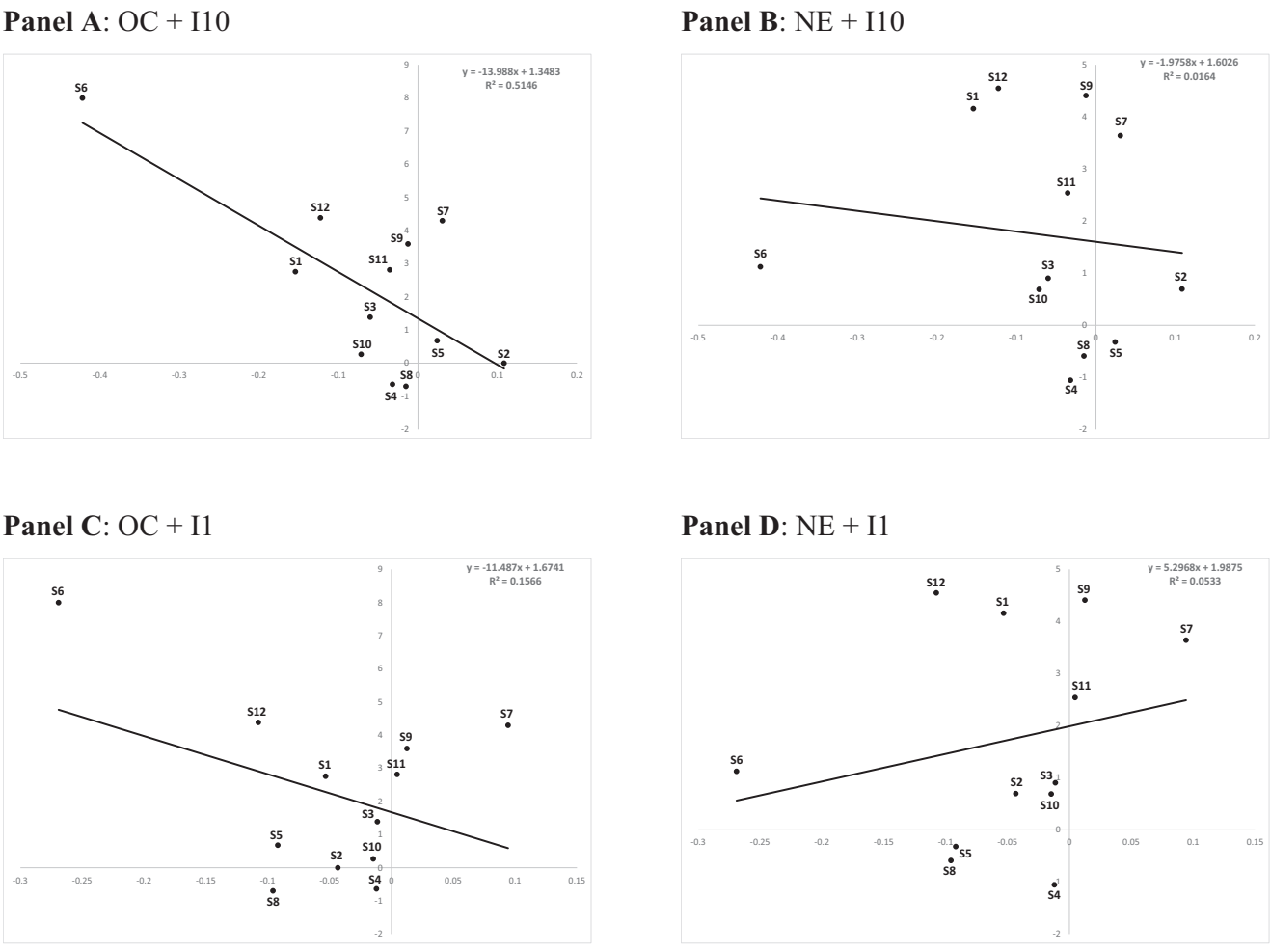

Fig. 1. Relationship between FTC (on the y-axis) and IRS (on the x-axis) at the sector level. Note: FTC shows the Flow-Through Capability, IRS displays the Interest Rate Sensitivity for each sector, OC shows Operating Costs, NE is the Number of Employees, I1 exhibits the 1-year interest rates and I10 shows the 10-year interest rates.

employees, respectively. In Panel C, the coefficient γ_1 (-0.1097) is negative and statistically significant, in line with the previous literature (but not in Panel D). This relationship can be seen in the negative slope of the trendline (Panel C of Fig. 1). Finally, R^2 is close to 16%, so this explanatory power is quite high.

Therefore, in general, according to the four alternative ways to study the connection between IRS and FTC at the sector level in the US stock market, the relative location (in the graph) of each sector seems to be quite similar. Moreover, the abovementioned relationship appears to be negative and statistically significant, especially when the operating costs of companies listed on the S&P 500 index are taken as proxy variables of the production level and the alternative proposed by Cano et al. (2016) is applied. The study of the relationship between the IRS and the FTC using the average number of employees as a proxy variable does not show as strong a performance as do the previous estimates using operating costs. Thus, in general, these results may provide evidence for the Cano et al. (2016) proposal in both IRS estimates (with 10- and 1-year interest rates).

As shown in Fig. 1, sectors S7, S9, S11 and S12, that is, Finance and Real Estate, Manufacturing, Transportation and Warehousing and Utilities, respectively (with high FTC), are located above the regression line. Therefore, these results confirm the null hypothesis proposed in this research: industries with high FTC (S7, S9, S11 and S12) may be less sensitive (than expected) to changes in nominal interest rates according to Jareño (2005), Jareño and Navarro (2010), and Jareño and Tolentino (2012), among others. In contrast, sectors such as S4 (Retail Trade), S8 (Information) and S10 (Professional and Administrative Services) (with high IRS) are located below the regression line. Therefore, these sectors would be more sensitive (than expected) to changes in nominal interest rates because they do not show exceptional ability to transmit inflation shocks to the prices of their products and services.

In summary, the statistically significant relationship between FTC and IRS may corroborate the previous empirical results of Jareño (2006), Jareño and Navarro (2010) and Jareño and Tolentino (2012), who obtain a negative relationship between sensitivity of stock prices to changes in nominal interest rates and FT capability. However, this relationship varies among sectors depending on, e.g., the level of competition, corporate concentration, degree of liberalization, and labor productivity.

5. Conclusions

This paper focuses on the US stock market at the sector level. More concretely, it studies not only companies' capability to transfer inflation shocks to products or services prices but also their sensitivity to changes in nominal interest rates between 2000 and 2009. Finally, this research analyzes the connection between these measures.

Thus, the main purpose of this study is four-fold: First, this paper starts from the flow-through capability (FTC) estimates using quarterly data. Second, this research compares two alternative estimates of the FTC. Third, we obtain the interest rate sensitivity (IRS) using two different terms for the nominal interest rate: 1- and 10-year maturities. Finally, this study analyzes the relationship between the FTC and IRS for the US sectors using two different methodologies for each estimate.

As previously noted, the FTC of US companies listed in the S&P 500 index is analyzed using two alternative estimates. Specifically, the turnover of these companies is regressed against the US inflation rate and a proxy variable for the production level of the sector, which, for robustness, includes the average number of employees and operating costs. Regarding the FTC estimates, the sectors with a statistically significant capability to transfer inflation shocks to prices of their products or services are S7 (Financial and Real Estate), S9 (Manufacturing), S11 (Transportation and Warehousing) and S12 (Utilities). These sectors show a positive relationship between inflation rate and turnover (more able to pass the inflation rate on the products' or services' prices). In contrast, S4 (Retail Trade) shows a negative and statistically significant FTC (less FTC), in line with previous literature.

Specifically, to estimate IRS, sector stock returns are regressed against the market stock return (S&P 500) and the nominal interest rate in the US by observing two terms: 10- and 1-year. Hence, this research obtains two different and alternative IRS estimates. In general, the sectors with negative and statistically significant IRS are S4 (Retail Trade), S8 (Information) and S10 (Professional and Administrative Services). This result is in line with previous studies. Moreover, the impact of the long-term (10-year) interest rate on sectoral stock returns is higher than that derived using the short-term interest rate, as expected.

Finally, the relationship between the FTC and IRS is analyzed through a cross-sectional regression. For robustness, this research runs four different proofs to consider the two alternatives obtained for each estimate: the FTC and IRS. Thus, a negative relationship between the IRS and FTC emerges from the four proofs, which is in accordance with the results obtained by previous studies. Thus, those sectors with a greater ability to transfer any inflationary shock to their products' prices exhibit a lower sensitivity to changes in the inflation rate, and this higher FTC will maintain a negative relationship with IRS. Therefore, these results may have relevant implications for portfolio managers and investors, who should contemplate the FTC of each sector before an investment decision.

Declarations

Author contribution statement

Francisco Jareño: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Marta Tolentino: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Carlos Cano: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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